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Systems Change Education Catalog: A Review of the Field of Systems Change Education Programs, Approaches, and Outcomes

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Abstract

There is a proliferation of 'wicked problems' in modern society, such as climate change, inequality, and emerging epidemics and pandemics. Dealing with these wicked problems demands that we use new thinking methods about larger system issues. Fortunately, the field of systems change education is growing, developing new pedagogies, delivering content, and breaking boundaries at an increasing rate. The Transformations Community is a global community of practice that sits at the crossroads of systems change education, practice, and research. To capture this innovative time in the systems change field, the Transformations Community has developed the world's first systems change education catalog. This catalog is a valuable source of information for students, researchers, and practitioners interested in finding programs within the field of systems education. The catalog also acted as the data set for this field survey. This article reviewed the educational programs featured in the Transformation Community's system change education catalog for relationships and connections. These programs range from one-day workshops to weeklong retreats and bachelor's, master's, and Ph.D. programs. The analysis revealed three distinguishing characteristics of systems change education programs: audience, pedagogies, and competencies. This review is the first step towards producing a typology for systems change education by focusing on similar characteristics within educational programs. This field is still emerging, and the Transformations Community aims to capture and promote new developments and innovations in pedagogical methods for systems change education.

Introduction

There is an urgent need to realize a systems view to define, frame, and propose solutions to many of the problems our planet is currently facing (Daviter, 2017). In 2015, 193 countries adopted the 2030 Agenda for Sustainable Development. This agenda expanded on the previous Millenium Development Goals, focusing international efforts on the major complex issues of our time, poverty, environmental degradation, inequality, food security, health, and well-being. When

designing the Sustainable Development Goals, the architects understood how each goal was interlinked and interdependent.

The UN Decade on Education for Sustainable Development (DESD) gave a greater understanding of the challenges of sustainable development by highlighting how education was a "key enabler" to continually achieve success in sustainable development (UNESCO DESD Final Report, 2015). Professional development and higher education programs have a necessary and critical role to play in helping graduate students, and other professionals develop systems thinking competencies to equip them best to serve as systems leaders prepared to advance systems change. Numerous professional associations have cited the need for these competencies, researchers, and employers (AASHE, 2010; Wiek et al., 2011; ASAP, 2020). In light of this, Tabara and Chabay (2013) argue that the speed at which change is happening on earth also demands that we rethink our educational systems. There is a need to incorporate adaptive ways of thinking and educating that combine our understanding of human knowledge information systems and social-ecological knowledge (Tabara & Chabay, 2013). As we realize these new ways of thinking, we are required to embrace complexity and develop novel multi-stakeholder strategies that are adaptable and inclusive and support multiple viewpoints and relationships (Dreier et al., 2019). Importantly, transforming systems involves transforming the relationship between the stakeholders who make up our systems (Scharmer & Kaufer, 2013). Achieving Sustainable Development goals and solving complex issues will require "systems leadership" (Daviter, 2017, Dreier et al., 2019).

The Field of Systems Education

Systems thinking has been described as a "threshold" or core competency for sustainability practitioners (Sandri 2013) and as an essential skill to develop leadership skills for "systems leaders" of organizations and individuals alike for addressing complex issues (Arnold & Wade, 2015). Sustainability and systems thinking are inextricably linked, and it is impossible to identify solutions to interlocking problems like the SDGs without understanding interconnected systems (Cavana & Forgie, 2018, Gregory & Miller, 2014; Wells & McLean, 2013; Dreier et al., 2019). Furthermore, systems leadership skills are critical to promoting systems change (Arnold & Wade, 2015). Senge et al. (2015) describe three main core capabilities of a systems leader, (1) focusing on the system as a whole rather than the sum of its parts, (2) reflection, being able to reflect accurately on one's role in the system and (3) shifting the focus from reacting to problems, to co-creating the future. Similarly, one of the mindset skills that Arnold & Wade (2015) attribute to systems thinkers is the ability to view problems from multiple perspectives, in many ways focusing on the whole system.

Importance of Systems Change Education

Systems change education is a complex field with many different dimensions, as shown in Figure 1, which combines the perspectives of some of the leading educators in the field.

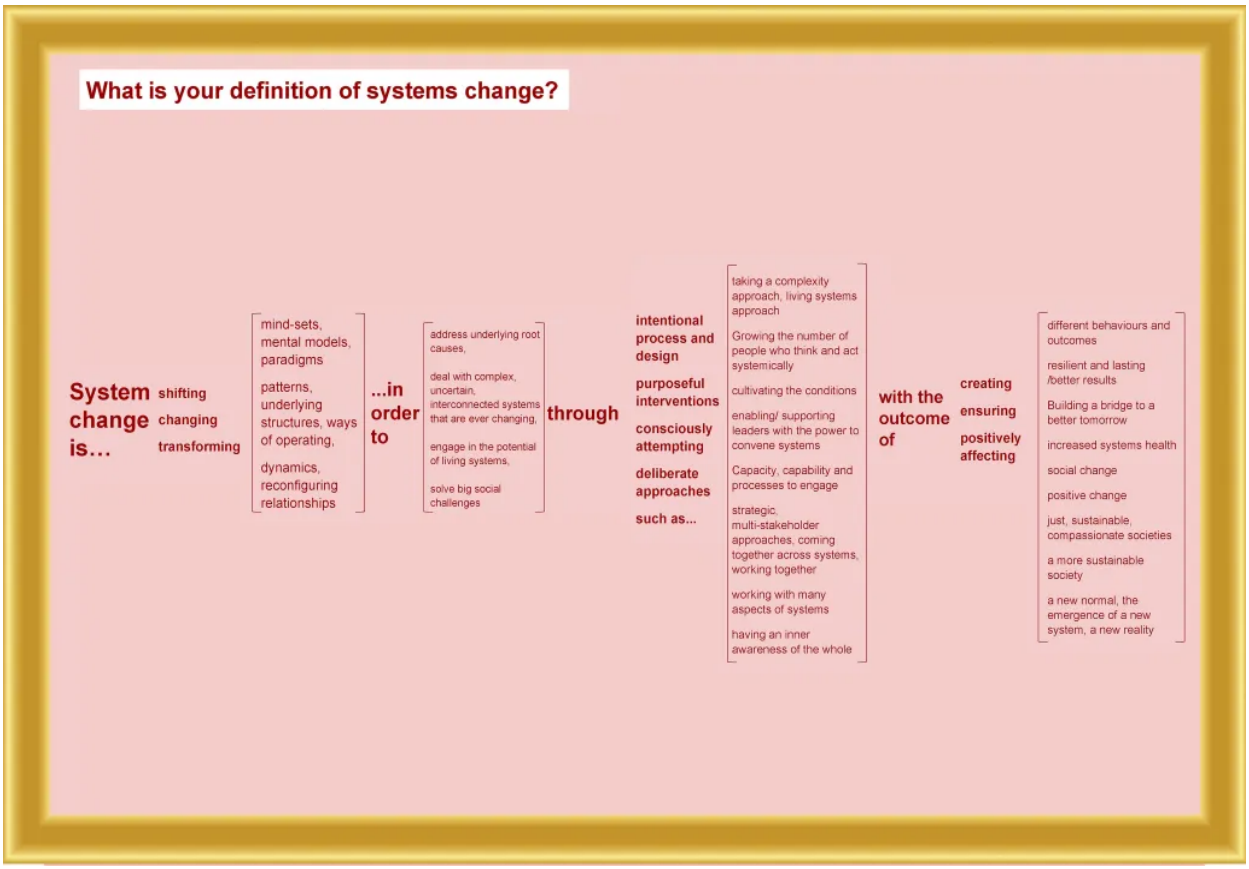

Figure 1 Systems change definition. Anna Birney, Darcy Riddel, Systems Change: A field building convening, 2018.

Considered in the aggregate, these are essential skills for anyone hoping to contribute to the transformations necessary for our time (Beehner, 2019; Stroh, 2015; Wiek et al., 2011; Birney et al., 2018). However, defining them is the easy part. The bigger challenge is figuring out how to develop and cultivate these skills so that enough people can access them to bring about the changes we need in the time we have left. A recent editorial article in Nature stated, "Time is running out and there needs to be committed action and focus, if we are to adapt to the pace of change" (Nature, 2022, p.693).

The Field of Systems Education

Educational programs are developing new innovative curricula and pedagogical approaches to keep up with the societal transformation necessary and to develop essential competencies. Just as life exploded on earth, throughout the Cambrian era, with wild biological and anatomical possibilities, systems change education programs are innovating and developing rapidly (Goldstein, 2020). It is difficult to know which approaches will succeed and which will fall to the wayside at this stage. Still, the demand for new systems-led approaches and competencies is evident through the increasing number of programs being suggested for the catalog database.

Rationale for this article

The Transformations Community has aimed to keep up with the innovative and varied methods of teaching that are being developed in the field of systems change. These diverse program designs can be seen throughout the TC's catalog of new systems education initiatives, targeting degree-seeking students, individuals (from all walks of life and sectors), and working professionals. It's a time of wild pedagogical innovation, accompanied by plenty of uncertainty on how to train people to do the many things needed to bring about systems change. The field is rapidly growing while feeling its way through by deploying highly diverse principles, methods, and techniques. The Transformations Community aims to keep up with new emergent programs, research, and professionals. This article aims to survey the field and the advances in systems change education in its current state for common themes and patterns to summarize the field in a report.

The Transformations Community (TC) is working to bring systems educators and program administrators together to develop the field of systems change education. The mission of the TC is "to increase people's capacity to transform social-ecological systems to achieve desirable futures that are sustainable, regenerative, just, and equitable by rapidly co-creating and amplifying knowledge, capacities, learning and action" (Transformations Community, 2022). To accomplish this, there is a need to incorporate new ways of thinking and crossing boundaries and disciplines (Argento et al., 2020). Therefore, the TC operates at the "interface between research and practice, knowledge creation and action," acting as a "bridge to connect people working to catalyze transformations across different sustainability-related domains (e.g., water, energy, food, biodiversity), siloed disciplines and fields, places and cultures, and institutional settings." Our commitment to developing the field of systems change education is essential to our mission.

This article is proposed as a companion piece to the Transformations Community's Systems Change Education Catalog (Transformations Community, 2022). Our catalog is the world's first directory of systems change education programs. This open-access directory forms a valuable resource for students who want to begin a career in the field and those wanting to enhance their career or make career changes. It also benefits academics and practitioners interested in connecting with each other and being exposed to the latest teaching practices and developments in the field.

Methodology

The data set used was the TC's systems change education catalog. The 118 programs in the catalog (as of October 2022) were selected for inclusion in the catalog based on these criteria:

Programs have to meet both (1) and (2):

1) Programs that enroll students/clients for a fixed period of time and have an established curriculum.
2) Programs whose primary purpose is to train systems change agents, as evidenced by:

a) Explicitly describing their focus on systems change in their program websites

b) Programs that are repeatedly offered and will be offered in the future (i.e., not one-off workshops)

c) Addressing issues that pertain to sustainability, environment, and social-ecological systems

Programs can be proposed through the Transformations Community website, via the "suggest a program" function, through transformations community members or staff, and are also suggested through an internal online database, Airtable.

Programs that meet the above criteria were entered into another field in Airtable (to be reviewed) and are reviewed internally by TC staff to check for validity. All relevant information pertaining to the course is added to this database. Relevant information included course details, learning outcomes and approaches, duration, fees, location, and course contacts. Once approved, the program administrator was contacted to see if they consent to being featured and provide further relevant information on their program. There is no fee for being included in the catalog. Once this approval was obtained, the program administrator was given the option to review the material featured in the catalog, including an overview of the program, "program summary," "program details" (i.e., duration, intensity, level, format, the language of instruction, intended audience and cost), "program location" and "learning approach and outcomes." The details to be featured are cross-checked, and final approval is given to publish the program in the catalog. For this analysis, we selected only the information regarding the program summary, learning approaches, and learning outcomes provided for each program entry.

Axial Coding

Analysis of the data set (n=98) was carried out using axial coding (Simmons, 2017). There are several other ways to carry out this type of qualitative analysis, including Braun & Clarke's (2006) thematic or qualitative content analysis (Mayring, 2000). Axial coding was chosen, as it permitted the breaking down of the large dataset (the TC catalog) into smaller codes through open coding, these codes were then formulated into categories and later grouped in similar categories, then forming the typology outlined below.

Programs were selected based on their inclusion in the Transformations Community catalog.

Exclusion criteria:

Programs were not selected on the basis that the learning approaches section was incomplete in the course catalog (n=5), and the program featured in the catalog was no longer featured on the organization's website (n=9). The learning approaches section is essential as it outlines what the program aims to deliver to students and what they will be able to do (i.e., what competencies

they will achieve) upon completion of the course. If this section was not completed for the catalog, the program was not considered for the qualitative analysis.

The qualitative analysis process is outlined below:

1. Programs were reviewed individually on the TC catalog to check for all relevant information.
2. Programs with all relevant fields* included were then copied and pasted into an excel sheet including all relevant fields, the program title, and the institution.
3. Initial coding was conducted to review similarities within programs based on the data provided
4. This coding revealed several overarching categories.
5. These categories were coded further independently from one another.
6. This analysis was reviewed and went through several iterations before finalizing the three categories and subcategories.

*Relevant fields included: Program Summary, Program Details, Learning Approach, and Outcomes

Network Visualization

The network visualization analysis reveals connections, similarities, differences, and clusters of programs using Gephi.org, a systems visualization tool. The process of creating the network maps is outlined below:

1. Use Excel to create a database of programs with various attributes entered as columns.
2. Load this database into Table2Net to create a network file, then load the network file into Gephi.
3. In the Layout window, run Force Atlas to arrange program nodes into a network layout.
4. In the Statistics window, under Community Detection, run the Modularity function to calculate communities.
5. In the Appearance window, under Nodes, choose to partition by Modularity Class. This applies a unique color to nodes of a particular community

Results

Systems Change Education Catalog

31% of the 114 programs (n=36) are degree-granting programs (as shown in figure 2.1). These are separated into Master's (n=28), Bachelor's (n=1), Ph.D. (n=5), Course Specialization (n=1) and Grad Minor (n=1). The other 69% are personal or professional development. In total, 39% of the programs (n=46) are full-time, and the other 61% (n=68) can be offered part-time (as shown in figure 2.2). 37% of programs are delivered in person (n=42), 51% are delivered remotely

(n=58), and 24 programs are delivered both in person and remotely (as shown in figure 2.3). There are a total of 13 countries where programs are offered in person (as shown in figure 2.4).

Figure 2.1. Percentage of programs that are degree-granting compared to personal/professional development.

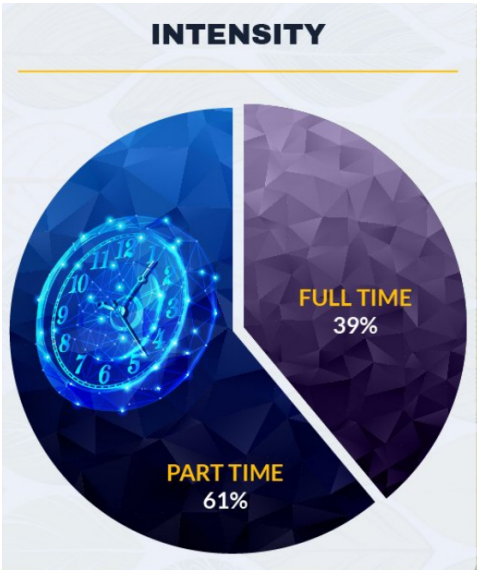

Figure 2.2. Percentage of programs that are delivered full-time compared to part-time.

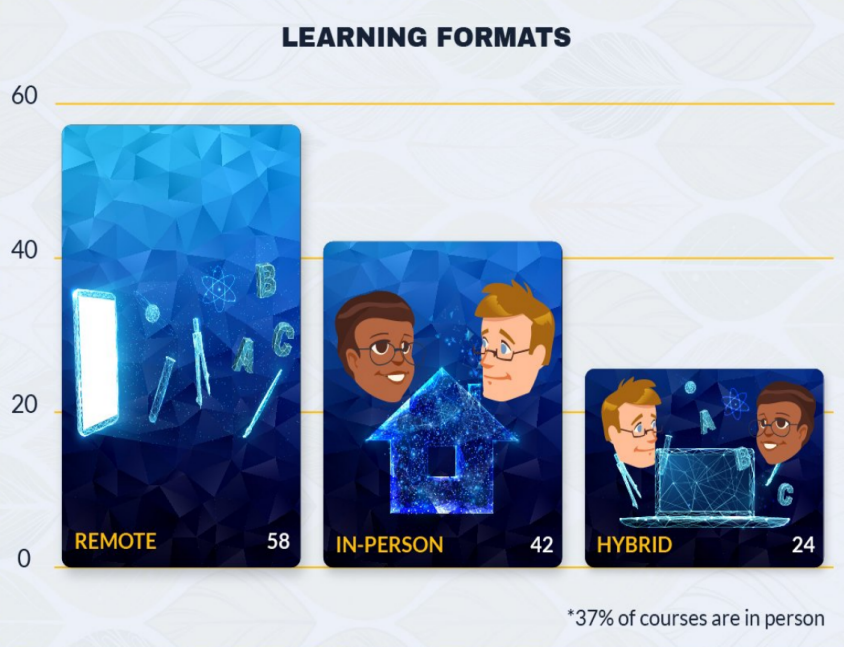

Figure 2.3. Number of programs that are delivered remotely, in-person and hybrid.

Figure 2.4. Geographical representation of programs delivered in person.

Axial Coding

This analysis revealed codes, categories, and subcategories amongst individual answers to display similarities and connections within the dataset. This analysis aimed to produce a report on these categories and subcategories. The coding analysis aimed to develop relationships between the many programs featured within the TC systems change education catalog. This process was dynamic and went through many iterations before settling on the final categories and subcategories, seen below:

Axial coding revealed three main categories: competencies and capacities, pedagogies, and audience, each with several subcategories, see Table 1.

1) Competencies and Capacities

What each program aims to provide students once they successfully complete the course. The subcategories within this theme are leadership, collaboration/interpersonal, research, self-awareness, systems thinking and problem-solving, design, and innovation (as shown in figure 2.5).

2) Pedagogies

The different types of pedagogies employed throughout the course. The different pedagogies that are employed throughout systems change education are transformative learning, traditional (teacher-centered), project-based, peer-to-peer, inquiry-based, and mentorship (as shown in figure 2.6)

3) Audience

The intended audience for the program or which groups in society will be best suited to participate in and complete the program. Programs featured within the systems change education catalog are intended for students (undergraduate and postgraduate), working professionals, and action researchers (as shown in figure 2.7).

Catalog Characterization		
Competencies and Capacities What the program aims to provide students after successful completion of the course.	**Pedagogies** The different types of pedagogies offered to learners and cohorts.	**Audience** Who the program is designed to serve.
Leadership	Transformative learning	Students/Clients
Collaboration/Interpersonal	Traditional (teacher-centered)	Working professionals
Research (critical analysis)	Project-based or Integrative	Action researchers
Self-awareness	Peer-to-peer	
Systems Thinking	Inquiry-based	
Problem Solving: Design and innovation	Mentorship	

Table 1. Themes and subthemes identified, following thematic analysis of systems change education catalog.

Network Visualization

Competencies

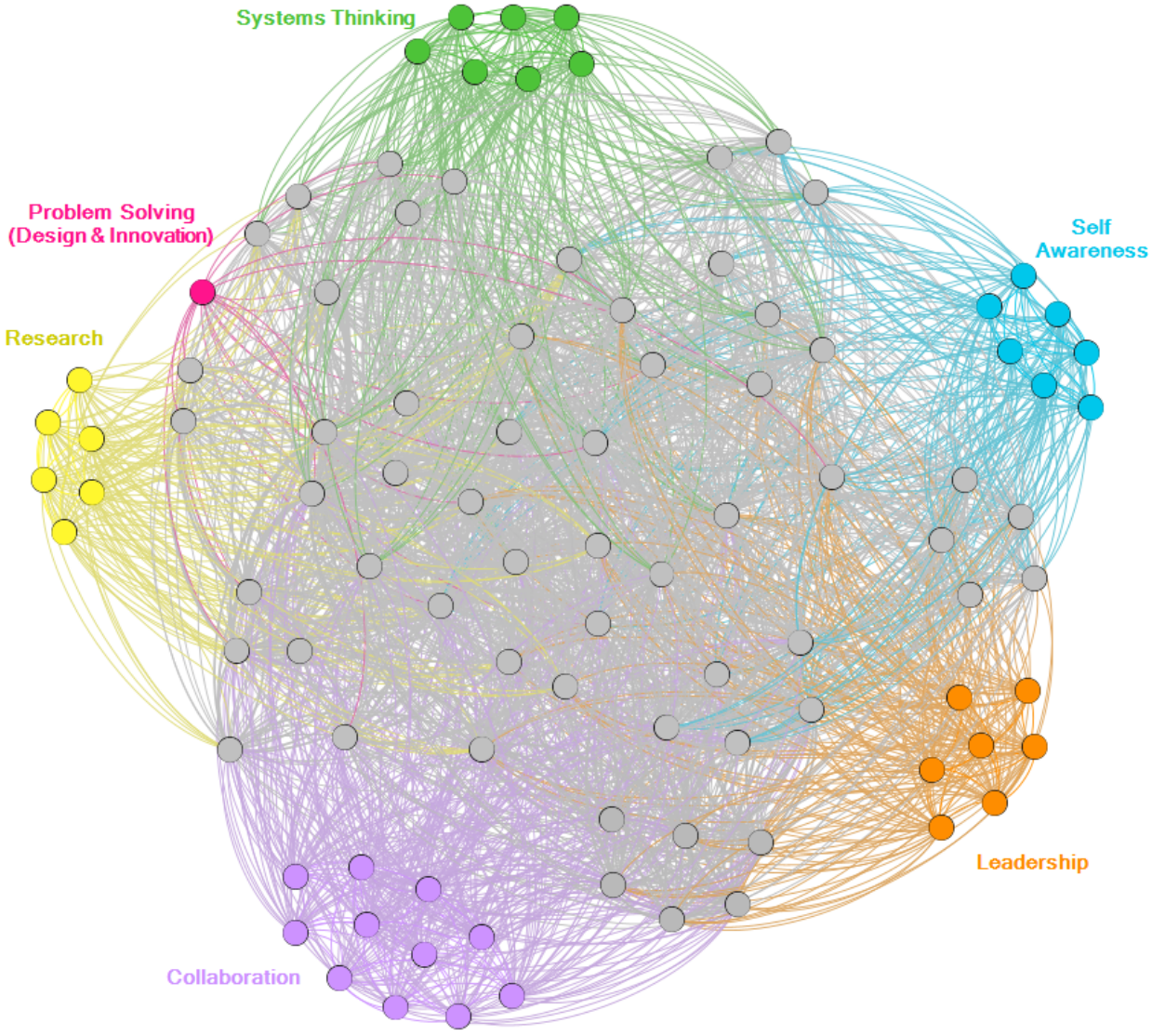

Figure 2.5. Network visualization of the competencies developed through programs in the systems change education catalog.

Following the axial coding, several groups of competencies emerged. The groups identified in Table 1 were mapped visually with the network mapping tool. These groups are displayed here as collaboration (purple), leadership (orange), self-awareness (blue), systems thinking (green), problem-solving (pink), and research (yellow). The further the group is away from the center of the map, the fewer interactions it has with other competencies. For example, the program

represented by the problem-solving pink node has fewer interactions with other competencies. Programs represented by nodes near the map's center have more connections with other competencies.

Pedagogies

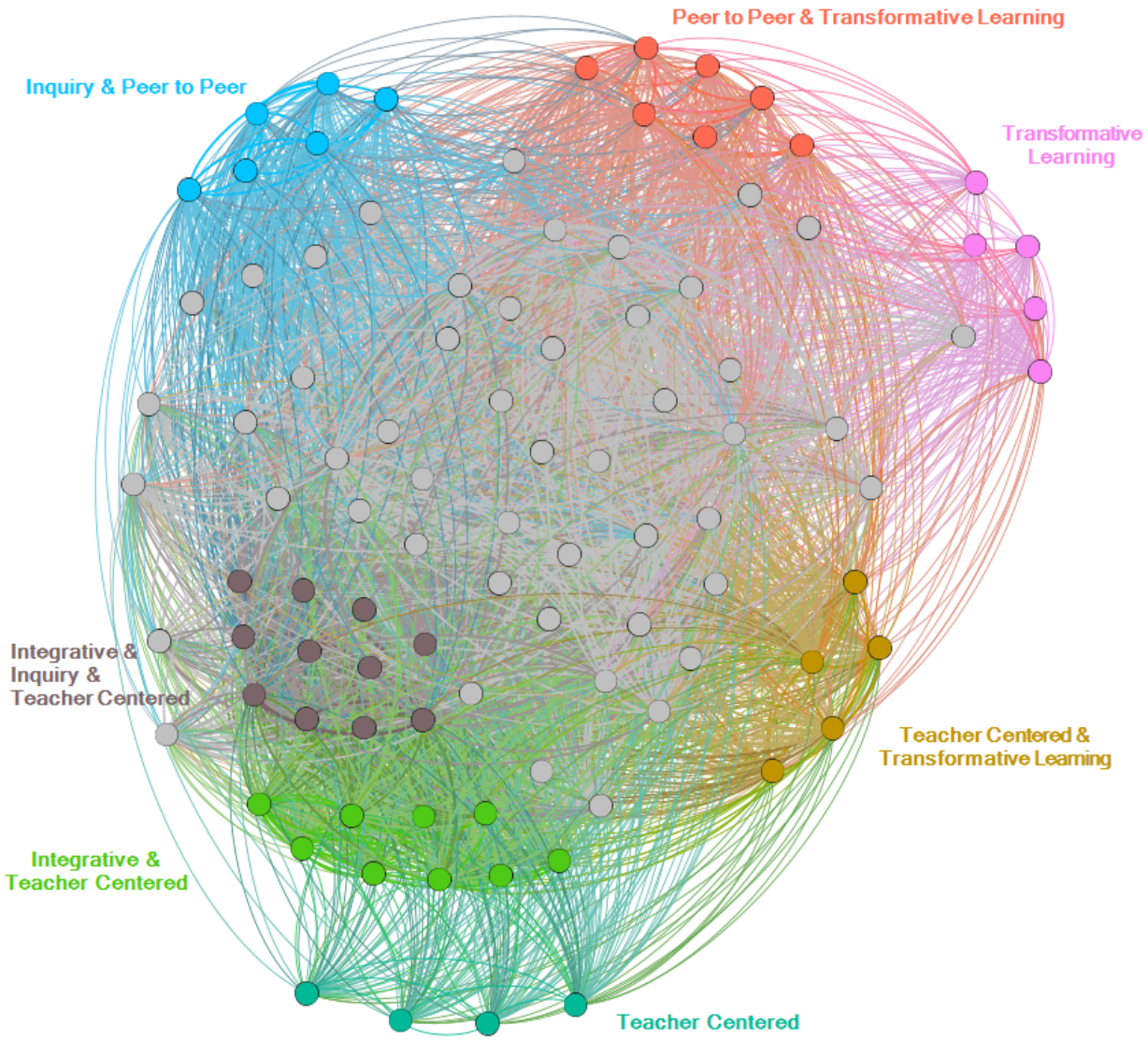

Figure 2.6. Network visualization of pedagogies delivered through programs in the systems change education catalog.

Programs represented by the nodes are shaded by their particular focus on the pedagogy utilized. The mapping analysis revealed communities of programs that focus on just one pedagogy. For example, teacher-centered programs are represented by the aquatic green color. The study also

revealed groups of programs that deliver similar pedagogies. For example, teacher-centered and transformative learning pedagogies are grouped and represented by the brown color. Programs that provide several combinations of pedagogies are situated closer to the middle of the mapping analysis.

Audience

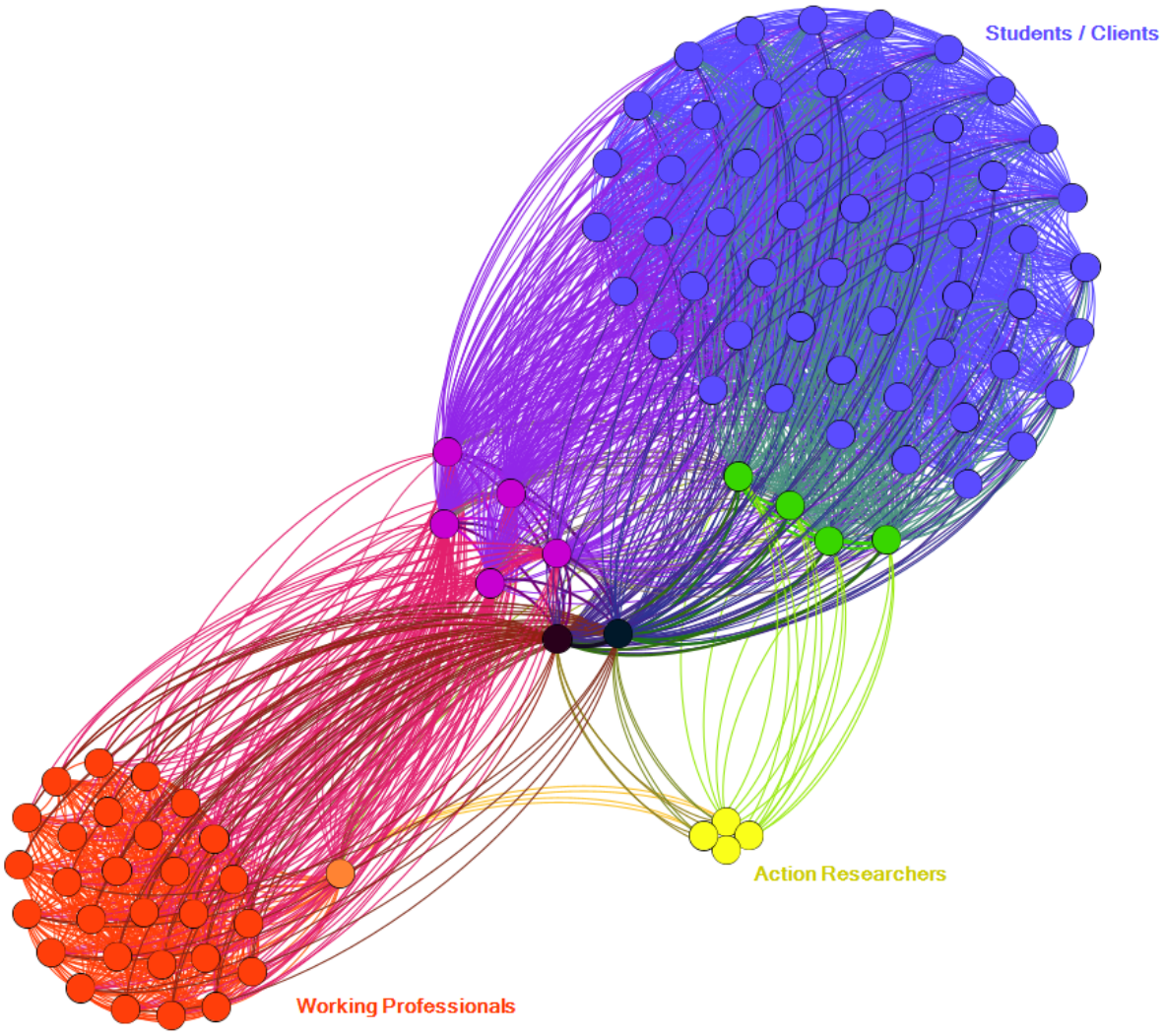

Figure 2.7. Audience for programs featured in the systems change education catalog.

There are three audiences for the several programs featured in the systems change education catalog, working professionals (red), students/clients (blue), and action researchers (yellow). Some programs share audiences, such as those represented in purple and black, which share all

three audience groups. The program in orange is targeted toward working professionals and action researchers. The programs in green are targeted toward action researchers and students/clients.

Discussion

The axial coding aimed to summarize the field of systems change education, what learning approaches are taken, and what the learning outcomes for stakeholders interested in the area of systems change are. The network mapping aimed to represent this coding visually, showing the interconnections between many programs and their approaches.

Analysis of the programs featured in the TC catalog revealed a new way of organizing, thinking, and talking about these programs, a new typology for systems change education: educational programs are tailored for specific audiences, and these audiences select the program based on competencies they want to achieve and through the pedagogies that will deliver these competencies, that will allow students to contribute to systems change.

Audience

Systems change education attracts people from diverse backgrounds seeking alternatives to society's pressing challenges, such as climate change, inequity, and sustainable consumption. We've identified several audiences through axial coding and mapped these visually (Fig. 2.7).

Students/Clients

Only some students seek a degree; many are clients seeking personal development. For example, Way of Nature delivers programs such as the 28/44 Day 'AllOne' Solo, Source Awareness Fellowship, and others. These programs teach systems change through personal and self-awareness. These individuals seek personal development and can be classified as students/clients in these programs. However, within this category, there are degree-seeking students. Undergraduate and postgraduate students make up 33% of programs, with the remainder unequally distributed among Masters, Post-Graduate, Ph.D., and Postdoctoral programs. At the undergraduate level, Gaia University delivers the Bachelor of Science program. This program is a "three year online degree that emphasizes clarifying and fulfilling personal vision while creating a regenerative livelihood." Masters level programs include the Master of the Environment Program at the University of Colorado Boulder, Ph.D. programs include the Ph.D. in Transformative Studies from the California Institute of Integral Studies, and Postdoctoral programs include PostDoc Academy for Transformational Leadership.

Working professionals are also a major audience for systems change education. These include programs for current practitioners and professionals from several fields seeking to further their careers with additional systems change competencies. 'Designing for Social Systems Workshop' from 'Stanford d.school' is a program that brings together "leaders and practitioners in the

nonprofit, philanthropy, government, and social impact fields to work in more effective, human, and strategic ways."

These categories can overlap (as shown in figure 2.7); degree-seeking students can be working professionals, and action researchers can also be students, represented through the purple and black areas seen in figure 2.7. Programs targeted towards working professionals that provide a degree certification include the Executive Master of Natural Resources in Leadership for Sustainability from Virginia Tech, which emphasizes that "this program is offered for working professionals." Other programs offered to working professionals are sector specific such as the Investors in Change program offered by Forum for the Future. In addition to the Ph.D. and Postdoctoral programs offered to action researchers, there are courses such as the Earth Leadership Program, which "prepares academic sustainability researchers to collaborate as effective agents of change by providing tools and perspectives to help participants cross traditional disciplinary and sector boundaries." This last idea is important: to effectively contribute to improving our view of systems and the challenges therein, programs must promote transdisciplinarity and integrate research from several other disciplines and professional practices.

Pedagogies

Pedagogy, the method and practice of teaching, is a "range of things you do to know" (Cope & Kalantzis, 2015). Systems change education is an emerging field, and several different pedagogies are employed with it. These pedagogies can be used in isolation or combination with other forms. Including more than one or several pedagogies allows the educator and learner to "deepen" their understanding of the content being delivered (Cope & Kalantzis, 2015) and, therefore, contribute effectively to systems change. Below is the first typology of systems change education pedagogies, an attempt to characterize the several pedagogies utilized in educational programs featured in the TC catalog. Figure 2.6 demonstrates the variety of approaches undertaken through several programs. Few of the programs featured in the systems change education catalog utilize one pedagogy; most employ several. The several pedagogies identified through this thematic analysis were traditional, integrative/project-based, peer-to-peer, transformative learning, inquiry-based, and mentorship. Most programs choose to deliver several pedagogies to their target audience (as shown in figure 2.6). The most used pedagogy pairings are also seen in figure 2.6, including 'inquiry and peer-to-peer' (blue), 'peer-to-peer and transformative' (orange), 'teacher-centered and transformative learning' (brown), and 'integrative and teacher-centered (green).

1) Traditional or Teacher-centered

   This type of pedagogy is based predominantly on the relationship between the learner and the teacher, traditionally known as providing a learner, the student, with knowledge from someone who already knows the teacher. It is the predominant teaching method across most formal education (Souleles, 2017). This type of pedagogy is utilized in programs that contain traditional workshops, lectures (virtual or on-site), and traditional courses

(short or long-term). The provision of lectures is a common example of traditional pedagogy, "lectures, talks, seminars and workshops" (MSc Sustainability and Behaviour Change, Center for Alternative Technologies). Notably, as was identified by Tabara & Chabay (2013), traditional learning methods must be reconsidered and adapted to keep up with the pace of change.

Furthermore, Souleles (2017) argues that traditional teaching methods centered on the "master/apprentice" dynamic do not allow us to contribute successfully to systems change. There needs to be a move towards user-centered, evidence-based approaches incorporating empathy (Souleles, 2017). Therefore, traditional or teacher-centered learning methods are rarely used in isolation but rather a combination of pedagogies throughout the systems change catalog. For example, the MA in Social Innovation by the University of San Diego delivers a course that aims to increase knowledge through classes. Still, students also learn multiple approaches to effectively and sustainably design and implement solutions.

2) Integrative

Integrative pedagogies allow learners to put their skills into practice through projects, internships, and other real-life experiences. Similar to the other pedagogies identified, these are often delivered in combination with others, such as traditional teacher-centered methods. This subcategory also incorporates experiential learning, as it is ultimately "learning by doing or experiencing" and therefore integrating knowledge. Examples include "paid professional internship" (Maitrise en Environment, ECAMT Canada), and "Apply these learnings in real-time" (Presidio Graduate School). The Masters in Regenerative Action from Ubiquity University, "content that is being developed will be linked to practitioners in the field working to regenerate bioregions, cities, and economies globally." Integrating all types of knowledge and learning is essential for systems change. We need to take a varied and holistic approach (Daviter, 2017). In the report by Birney et al., they describe what they call the educational ecosystem approach, which brings together actors from academic settings, such as students, lecturers, and administrators, with community members, organizations, and local government. This educational ecosystem approach typifies integrative pedagogy. It is employed in such programs as the Changemaker Journey by Ashoka, "Key stakeholders are invited to gather for a series of experiences facilitated by Ashoka staff. These stakeholders include (but are not limited to) teachers, children, policymakers, and business professionals."

3) Peer-to-peer

This form of pedagogy has increased in popularity for several years to encourage change toward more environmentally positive practices (Heidenreich & Breukers, 2020). It is a form of teaching in which a smaller number of representatives from a group attempt to inform other members about issues they are experiencing (Svenson et al., 1998). These pedagogies incorporate the knowledge of existing communities or hope to create new

ways of thinking that might not otherwise have been delivered. Included within these pedagogies are those that are transdisciplinary and interdisciplinary. These are essential elements of systems change education. Crossing and breaking down boundaries of different disciplines, peers "share their thoughts, learn from each other, build networks and create a shared understanding" (Sitra Lab, Sitra).

4) Transformative Learning

Transformative learning is a theory of adult learning by Jack Mezirow (from Mezirow, 2000, p. 22), who described it as "learning that transforms problematic frames of reference to make them more inclusive, discriminating, reflective, open, and emotionally able to change." One major element of systems change education is reflexive practice. It is incorporated in many different programs, from one-off certificates to degree-granting programs. A reflexive pedagogy allows learners to think about how they have been affected by the program and how their knowledge, opinions, and practices may or may not have changed over the course of the program. As the Systems School describes, their students "engage in personal reflection about your role in the system, your personal power and your experience of power in the system" (Virtual Learning Series Power in the System, The System School). This approach to understanding ourselves and our role within socio-ecological systems is fundamental to the field of systems change, as Morrell & O'Connor (2002) put it, "Transformative learning involves a deep structural shift in the basic premises of thought, feelings and actions. It is a shift of consciousness that dramatically and permanently alters our way of being in the world. Such a shift involves our understanding of ourselves and our self-location: our relationships with other humans and with the natural world" (Morrell & O'Connor, 2002). The Regenerative Practitioner course (Regenesis Institute) is a good example of a program that focuses on transformative learning for the self that then aims to evolve society - as they put it, "Regenerative practice is based on the premise that we cannot make the outer transformations required to create a truly sustainable world without making inner transformations in how we think, how we work, and who we are." Other pedagogies that emphasize the personal journey through reflection on how individual change are also included here, such as spiritual practices of meditation and prayer, which are organized by the Gaia Education Design for Sustainability program, run by the Gaia Institute.

5) Inquiry-based

This type of pedagogy is incorporated when students or learners undertake research. Over the course of their program, as students' knowledge and or skills develop, they propose solutions, develop theory, or test research hypotheses. This includes methods of critical analysis and other question-based analyses, such as the Ph.D. program in Transformative Studies at the California Institute of Integral Studies, which states that "The course of study is transdisciplinary, it is inquiry-driven" (California Institute of Integral Studies, 2022). Many degree-granting programs featured involve several inquiry-based tasks such as thesis writing or report writing. For example, "The Master of Arts and the Master of

Science in Sustainability, offered on ASU's Tempe campus, is a research-oriented degree program that culminates with either a thesis or a capstone in the form of a publishable, scientific paper."

6) Mentorship

The final category of pedagogies is mentorship. This is when the learner is individually guided through their learning journey. Mentors can emerge within traditional learning, but to be included within this category, the program must explicitly state that they're offering guided learning by facilitators or mentors, such as Virtual Learning Series Power in the System at the System School Practitioner program in transformative learning communities by the Transformative Learning Foundation, which states that "You choose your overall mentor based on your area of interest."

Systems change is constantly evolving and developing, and further research is required to understand which pedagogies deliver which competencies. It is important to note that most programs deliver their degree/certificate through several of the pedagogies described here, as seen in the large number of overlapping pedagogies in figure 2.6.

Competencies

This category is defined by what a student or learner will be able to do to achieve success in the next stage of their systems journey. Competencies can be defined as the ability to do something successfully or skillfully or the set of demonstrable skills or characteristics that enable one to perform a job or task successfully. Competencies are the knowledge and tools that allow one to contribute to societal transformations effectively. While many competencies can be considered within this category, we have narrowed this to six principal subcategories. As demonstrated in figure 2.5, some programs specialize in delivering some competencies, whereas others provide several competencies focused on developing a broad skillset. Systems change education incorporates many different types of learning and engagement structures that support students' and practitioners' ability to contribute to systems change (Birney et al., 2019). The target audience for systems change education programs can develop one or more of these competencies through the course content and pedagogies employed. Rarely does it occur where a student will develop skills or knowledge in isolation. This list cannot cover all the necessary competencies as many are context specific (Birney et al., 2019); however, the following competencies were explicitly mentioned throughout the catalog for this research article. It is important to note that none of the programs featured in the catalog have proposed any guidelines or standards for successfully attaining a given competency. Instead, they suggest that students develop these competencies upon completion of their program. Understanding frameworks and concepts was mentioned as a learning outcome for several programs. However, this will be something that will underline all programs and courses.

Not surprisingly, we noticed a correlation between the pedagogies used and the competencies taught. For example, transformative learning is a form of learning that allows personal reflection

on one's role within systems and enhances a student's self-awareness. Self-awareness has been described by many educators and practitioners as essential to the process of systems change (Birney et al., 2019). The MA in Transformative Leadership from the California Institute of Integral Studies "mobilizes students' creativity to facilitate personal and social transformation" through students engaging "in self-inquiry with tools such as 360-feedback process, synergic inquiry, cycles of action and reflection, and contemplative practices". More research is required to determine which pedagogies are better utilized to equip learners with certain competencies.

We review the further five competencies: leadership, systems thinking, research (critical analysis), collaboration, and innovation. These competencies have been described in the marketing material for the systems change education programs featured in the TC catalog. Where possible, there has been a description of how each program aims to develop these competencies or capacities within its students. However, there are no standards provided on how each institution tests for the achievement of individual competencies or capacities, perhaps with the exception of the research competency. Further research should focus on developing standards for monitoring and evaluating the competencies described in each program.

Leadership

Leadership is a prominent competency mentioned by many programs in the systems change education catalog. Indeed, systems leadership is mentioned as necessary for moving societal transformations forward (Daviter, 2017, Dreier et al., 2019) and promoting systems change (Arnold & Wade, 2015). Several programs focus their curricula on developing leadership, such as the "Transition Leadership Lab" by Susanna Carmen Integral Design, "Masters in Strategic Leadership towards Sustainability," by Blekinge Institute, and "Earth Leadership Program," by University of Colorado Boulder, Future Earth, among many others. Students in the Transition Leadership Lab course are tasked with "providing organizing structures and leading processes" to prepare people and systems. It is envisioned that through this process and program, students will "enhance their own leadership capacities."

Systems Thinking

Solving wicked problems and the great challenges modern society is currently facing cannot be solved with 'narrow-thinking.' Furthermore, many of our great challenges arose through failures to think in systems and view issues on a larger scale (Meadows, 2008). While there are many definitions for systems thinking, Arnold and Wade (2015) provide a useful summary that "systems thinking is a set of synergistic analytic skills used to improve the capability of identifying and understanding systems, predicting their behaviors, and devising modifications to them in order to produce desired effects. These skills work together as a system". This competency is stated by several programs such as the School of Systems Change Basecamp, which asserts that "together we will think in systems, design strategies, implement and innovate systemically and reach for wider impact" and the MA/MS in Sustainability Science and Practice from Stanford University, which notes that there, "Students learn how to intervene in complex systems for transformative impact by exploring frameworks and tools from systems thinking,

design thinking, social cognitive theory, behavioral economics, and partnership strategies." While no program has stated the standards at which each student has achieved this competency or not, Senge (2006) puts forward three characteristics of systems thinking that could be useful for future references. These include: (a) consistent and strong commitment to learning, (b) challenging one's own mental model, and (c) thinking from multiple perspectives.

Research (Critical analysis)

Research and critical analysis are necessary for any natural or social science field. Understanding systems change depends on academics and practitioners moving the field forward through methods training, theoretical study, and supervised research opportunities. For example, Ph.D. supervision by Drift Academy allows researchers to explore "transdisciplinary research in transition studies." Similarly, the Ph.D. in Sustainability Science from the Stockholm Resilience Center focuses on "developing researchers." Through the four-to-five-year program, researchers will develop 'core skills' such as "research design, data analysis, scientific writing, and teaching," which can develop students' competency.

Collaboration

Systems are, in their very nature, a collaboration of connected interlinked parts that have characteristic behaviors. Collaboration and teamwork across disciplines and fields is essential to understand the systems within which we operate. Birney et al. described collaboration as an essential competency that systems change practitioners must develop to contribute effectively towards systems change. Combining networks, disciplines, research, and individual knowledge allows society to explore new ways of thinking outside silos and into new creative partnerships. The Investors in Change program is one program that brings together "decision makers" from diverse backgrounds to "cultivate connections globally with other investors in change and practitioners." While standardizing this competency is difficult, through partnership facilitation, it is hoped that boundaries can be broken down and collaborations achieved, providing the necessary skillset for practitioners to replicate this process.

Problem Solving (Innovation)

Last but not least, a key competency for systems change is being aware and able to lead problem-solving, specifically design, creation, and innovation. This category is fundamental to the system change field, since a critical aspect of system transition or transformation is imagining, designing, or creating a new system. This category encompasses programs focused on systems design, design for social change, and disruptive design. These programs are focused on creating new ways of thinking and doing and grounded in an understanding that what we are currently doing is not working and therefore creating new opportunities. For example, the Sitra Lab states that its "program focuses on one topic at a time through future labs, intensive programs based on future-oriented thinking, systems thinking and design thinking as well as the social innovation process" (Sitra Lab, 2022). Design for Sustainability by Gaia Education provides their students with "...whole systems design skills, analytical abilities and practical tools to support the

redesign of the human presence on Earth" (Gaia University, 2022). The Disruptive Design Masterclass by UnSchool is another example of a program that focuses on "dynamically designing and intervening in systems for positive social change."

Social innovation and entrepreneurship studies also fall into this category, as they aim to design and create new products or services. Some programs identify a need to go beyond the traditional role of social innovation education (Birney et al., 2019) of learning about an issue, designing an impactful product or service, and scaling it up to impact. As Birney et al. (2019) write, social innovation and entrepreneurship must begin to think systematically about the impact new products and services will have on a wider scale, addressing complex challenges. One example of this is the MA in Social Innovation (University of San Diego), which delivers a curriculum that "emphasizes experiential learning and human-centered design" to foster the student's ability "to develop sustainable, scalable solutions to tackle humanity's urgent challenges."

Conclusion

In conclusion, the systems change education catalog that the Transformations Community provides is a valuable resource for students, pracademics, and individuals interested in the field of systems change education to find and source information, whether you are a new student, pracademic or individual interested in the field. The catalog provided the data to review the field of systems change education. This is the first step in providing a systems change education typology. The analysis revealed many similarities, differences, and clusters based on audience, competency, and pedagogy. Hopefully, the catalog and this initial step will help students find programs that fit their needs, and help educators find colleagues to collaborate with, help program administrators steer and distinguish their programs, and help all of us better respond to the wicked challenges of the 21st Century.

Limitations

The major limitation of this research is that the programs featured in the TC systems change education catalog are geographically located in the Global North (primarily North America and the UK) and are taught mainly in English. Therefore, the typology proposed of the field is not representative of the global field of systems change education but rather a starting point from one geographical region.

Further Research

The field of systems change education is still emerging and developing, and new innovations are regularly happening. Capturing these innovations and developments will be a continuous process, and the TC will aim to do so through this catalog. Next steps based on this research will be to continually update the catalog and explore the categories further in collaboration with program administrators and students. In this regard, there should be a focus on including programs from non-English speaking countries and countries of the Global South.

Whereas this research article took an initial view of the field of systems change education programs, it opens up several more areas for research. Further research should focus on the connections between each identified category and explore what combinations of pedagogies and course material work best to develop certain competencies. For example, what competencies are being delivered to what audiences, and what pedagogies develop certain competencies? Like in the Cambrian era, where life flourished with millions of possibilities, systems change is emerging with myriad ways of achieving a desired positive future. This research can be an initial point for exploring many of these programs.

Finally, marketing material for each program states the competencies and capacities they hope to develop within students of their programs. However, there remain few objective markers for the achievement of these competencies. Further research should describe the standards for achieving each of these competencies or capacities.

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